DESCRIPTION

COOLING WAREHOUSE AND AIR REFRIGERANT TYPE COOLING SYSTEM

Technical Field

The present invention relates to a cooling apparatus using an air refrigerant and a cooling warehouse cooled by the cooling apparatus.

Background Art

A cooling apparatus using air as a refrigerant has been developed in recent years instead of a conventional cooling apparatus using chlorofluorocarbon as a refrigerant. This type of the cooling apparatus using a refrigerant air generally uses a system for performing cooling by directly blowing the air used as a refrigerant into a cooling chamber.

Japanese Unexamined Patent Publication No. 8-61821 (1996) discloses a low-temperature freezer for cooling a cooling space to a target temperature by a circulation equipment for circulating low-temperature air in the cooling space between the cooling spaces in a cooling portion outside of the cooling space, in which the circulation equipment for circulating the low-temperature air is systematized by arranging an air compressor, compressed-air cooler, expander, and

cooler in order of air flow in a circulation route, and constituted by including a main unit for expanding compressed air and generating low-temperature air, a mixing-injecting nozzle for mixing low-temperature air which is dried low-temperature air sufficiently dehumidified with the air in the cooling space and thereby directly injecting the mixed air into the cooling space, and an air intake hole for attracting the air from the cooling space and directly returning the air to the main unit.

Disclosure of Invention

In the case of the cooling of the cooling warehouse by the cooling apparatus using the air refrigerant, generally the amount of the airflow and wind speed are smaller than the case of a system using chlorofluorocarbon as a refrigerant. Therefore, when the vessel is large, it is difficult to sufficiently circulate low-temperature air in the warehouse and uniform the temperature in the vessel. In the case of a food warehouse, it is requested that the temperature distribution in the warehouse is controlled within 2 °C above and below a target temperature. Therefore, this problem is important.

The object of the present invention is to provide a technique for further uniforming cooling of the cooling warehouse using the air refrigerant type

cooling apparatus.

The cooling warehouse of the present invention has a first cooled-air introducing pipe introducing a first cooled air cooled by an air refrigerant type cooling apparatus, a second cooled-air introducing pipe taking in second cooled air in the cooling warehouse, and an air introducing port introducing the mixed air in which the first cooled air and second cooled air are mixed into the cooling warehouse.

In the case of the cooling warehouse of the present invention, the air introducing port is opened on a duct set in the cooling warehouse.

In the case of the cooling warehouse of the present invention, a second cooled air introducing pipe is set to the outside of the cooling warehouse and one end of the second cooled air introducing pipe is opened on the wall face of the cooling warehouse.

In the case of the cooling warehouse of the present invention, the second cooled-air introducing pipe is set inside the cooling warehouse.

The air refrigerant type cooling system of the present invention has the air refrigerant type cooling apparatus and the cooling warehouse. The air refrigerant type cooling apparatus has a compressor compressing the refrigerant air coming out of the cooling warehouse, a heat exchanger cooling the

refrigerant air coming out of the compressor, and an expansion turbine expanding the air refrigerant coming out of the heat exchanger and supplying the refrigerant air to the cooling warehouse. The cooling warehouse has a first cooled-air introducing pipe introducing the refrigerant air coming out of the expansion turbine, a second cooled air introducing pipe taking in cooled air in the cooling warehouse, and an air introducing port introducing mixed air in which the refrigerant air introduced by the first cooled-air introducing pipe and the cooled air are mixed into the cooling warehouse.

A transporting apparatus of the present invention has the air refrigerant type cooling apparatus, the cooling warehouse, and a carriage mounting the air refrigerant type cooling apparatus and the cooling warehouse. The air refrigerant type cooling apparatus has the compressor compressing the refrigerant air coming out of the cooling warehouse, the heat exchanger cooling the refrigerant air coming out of the compressor, and the expansion turbine expanding the refrigerant air coming out of the heat exchanger and supplying the refrigerant air to the cooling warehouse. The cooling warehouse has the first cooled-air introducing pipe introducing the refrigerant air coming out of the expansion turbine, the second cooled-air introducing pipe taking in the

cooled air in the cooling warehouse, and the air introducing port introducing the mixed air in which the refrigerant air introduced by the first cooled-air introducing pipe and the cooled air are mixed into the cooling warehouse.

The present invention provides a technique for further uniforming cooling of the cooling warehouse using the air refrigerant type cooling apparatus.

Brief Description of the Drawings

Fig. 1 shows a configuration of the air refrigerant type cooling apparatus of a background technique.

Fig. 2 shows the flow of air in a cooling warehouse.

Fig. 3 shows the flow of air in the cooling warehouse.

Fig. 4 shows a configuration of the air refrigerant type cooling apparatus.

Fig. 5 shows an air refrigerant type cooling apparatus mounted on a carriage.

Best Mode for Carrying Out the Invention

The best mode for carrying out the present invention is described below by referring to the attached drawings.

A configuration of an air refrigerant type

cooling apparatus is shown in Fig. 1. The cooling apparatus includes a freezer, a cooler, and an air-conditioning cooler (the same is applied to the cooling warehouse). This is because it is possible to apply the air refrigerant type cooling apparatus to freezing, cooling, and air-conditioning cooling by changing the temperature and pressure level of a system. The air refrigerant type cooling apparatus 1 has a compressor 2 to be driven by a motor 4. The compressor 2 is connected to a first cooled-air-type heat exchanger 6. It is also allowed to use a heat exchanger which is not the air cooling type as the first cooled-air heat exchanger 6. The first cooled-air heat exchanger 6 is connected to a second cooling heat exchanger 10. The second cooling heat exchanger 10 is connected to an expansion turbine 12 to be driven by the motor 4. The expansion turbine 12 is connected to the cooling warehouse 14. The cooling warehouse 14 is a warehouse having a door which can be opened and closed to form a space closed by closing the door inside. The cooling warehouse 14 is connected to the second cooling heat exchanger 10. The second cooling heat exchanger 10 is connected to the compressor 2.

In the above air refrigerant type cooling apparatus 1, the air discharged from the cooling warehouse 14 is introduced into the compressor 2

through the second cooling heat exchanger 10. The air is brought into a high-temperature high-pressure state by the compressor 2. The air discharged from the compressor 2 is air-cooled due to outside air by the first cooling heat exchanger 6. The outside air is circulated through the first cooling heat exchange 6 by a fan 8. The air coming out of the first cooling heat exchanger 6 is further cooled by performing heat exchange with the air discharged from the cooling warehouse 14 in the second cooling heat exchanger 10. The air coming out of the second cooling heat exchanger 10 becomes lower-temperature cooled air by being adiabatically expanded by the expansion turbine 12. The cooled air is introduced into the cooling warehouse 14 to cool the cooling warehouse 14.

A cooling apparatus using an refrigerant air generally has a larger temperature difference between a refrigerant (cooled air) and the inside of a cooling warehouse than the case of a cooling apparatus using chlorofluorocarbon as a refrigerant. Therefore, the air-refrigerant cooling apparatus requires smaller quantity and speed of the cooled air to be supplied to the cooling warehouse 14.

The flow of air nearby the cooling warehouse is shown in Fig. 2. The cooled air produced by the air refrigerant type cooling apparatus 1 is sent up to a

portion nearby the cooling warehouse 14 by a cooled-air introducing pipe 26. A hole is formed on the wall face of the cooling warehouse 14 and an in-warehouse-air taking-in pipe 22 is connected to the hole. The other end of the in-warehouse-air taking-in pipe 22 is connected to the cooled-air introducing pipe 26. A cooled-air feeding fan 24 to be rotated in the direction for supplying air to the connective portion with the cooled-air introducing pipe 26 from the hole on the wall face of the cooling warehouse 14 is set in the in-warehouse-air taking-in pipe 22.

The cooled-air introducing pipe 26 is connected to a duct 28 set in the cooling warehouse 14 at the downstream side of the connective portion with the in-warehouse-air taking-in pipe 22. A plurality of cooled-air blow-off ports 30 are formed on the duct 28.

Also, an another supplying mechanism for supplying mixed air containing air from the cooled-air introducing pipe 26 and the in-warehouse-air taking-in pipe 22 can be included instead of the duct 28 or with the duct 28. Such a supplying mechanism is preferred to distribute air to the wide range of the cooling warehouse 14. The supplying mechanism is, for example, a guiding plate guiding air to the number of places of the cooling warehouse 14. Also, a fan distributing air to the wide range of the

cooling warehouse 14 is preferred to be used in addition to the duct 28 or the supplying mechanism.

In the case of this cooling warehouse 14, the cooled air produced by the air refrigerant type cooling apparatus 1 flows to the cooled-air introducing pipe 26. The temperature of the cooled air is, for example, -60°C. The air in the warehouse 14 is taken into the in-warehouse-air taking-in pipe 22 by the cooled-air feeding fan 24. The temperature of the air is, for example, -30°C. The air incoming from the cooled-air introducing pipe 26 and the air incoming from the in-warehouse-air taking-in pipe 22 are mixed at the downstream side of the connective portion between the pipes 26 and 22. The temperature of the mixed air 32 is, for example, -40°C. The mixed air 32 is blown off from the cooled-air blow-off ports 30 of the duct 28 into the cooling warehouse 14.

In the case of an air-refrigerant cooling apparatus, the quantity and speed of the air blown off is small comparing with a cooling apparatus using a chlorofluorocarbon refrigerant. In the case of the cooling warehouse of this embodiment, however, the air in the warehouse is suctioned and added to the cooled air sent from the air refrigerant type cooling apparatus 1. Therefore, the quantity and speed of the air are increased. Therefore, the air in the

cooling warehouse 14 is agitated and the temperature distribution becomes flatter. Moreover, because the difference of the temperature between the mixed air 32 and the cooling warehouse 14 is smaller than the difference of the temperature between the cooled air sent from the air refrigerant type cooling apparatus 1 and the cooling warehouse 14, the temperature distribution in the cooling warehouse 14 becomes flatter.

Furthermore, in this embodiment, because the cooled air feeding fan 24 is placed at the outside of the cooling warehouse 14 and thereby, a motor for rotating the cooled-air feeding fan 24 is set to the outside of the cooling warehouse 14, the heat produced by the motor is not discharged into the cooling warehouse 14 and thereby, cooling is efficiently performed.

Fig. 3 shows the flow of air in the vicinity of a cooling warehouse of another embodiment of the present invention. The cooled air produced by the air refrigerant type cooling apparatus 1 is sent up to the inside of the cooling warehouse 14 by a cooled-air introducing pipe 38. An in-warehouse-air taking-in pipe 34 is set in the cooling warehouse 14. One end of the pipe 34 is opened at the inside of the cooling warehouse 14. The other end of the in-warehouse-air taking-in pipe 34 is connected to the

cooled-air introducing pipe 38 in the cooling warehouse 14. A cooled-air feeding fan 36 to be rotated in the direction for supplying air to the connective portion with the cooled-air introducing pipe 38 from one end opened in the cooling warehouse 14 is set in the in-warehouse-air taking-in pipe 34.

The cooled-air introducing pipe 38 is connected to the duct 28 set in the cooling warehouse 14 at the downstream side of the connective portion with the in-warehouse-air taking-in pipe 34. A plurality of cooled-air blow-off ports 30 are formed on the duct 28.

In the case of the cooling warehouse 14, cooled air produced by the air refrigerant type cooling apparatus 1 flows to the cooled-air introducing pipe 38. The temperature of the cooled air is, for example, -60°C. The air in the cooling warehouse 14 is taken into the in-warehouse-air taking-in pipe 34 by the cooled-air feeding fan 36. The temperature of the air is, for example, -30°C. The air incoming from the cooled-air introducing pipe 38 and the air incoming from the in-warehouse-air taking-in pipe 34 are mixed at the downstream side of the connective portion between the cooled-air introducing pipe 38 and the in-warehouse-air taking-in pipe 34. The temperature of the mixed air 40 is, for example, -40°C. The mixed air 40 blows off into the cooling

warehouse 14 from the cooled-air blow-off ports 30 of the duct 28.

This embodiment also has a large quantity and speed of air similarly to the case of the embodiment described by referring to Fig. 2. For this embodiment, advantages are expected that agitation of the air in the cooling warehouse 14 is accelerated and the temperature distribution become more uniform. Moreover, because the temperature of the mixed air 40 is closer to the temperature in the cooling warehouse 14 than the temperature of the cooled air sent from the air refrigerant type cooling apparatus 1, there is an advantage that the temperature distribution in the cooling warehouse 14 becomes flatter.

Moreover, in the case of this embodiment, it is unnecessary to perform the construction of opening a hole for setting the in-warehouse-air taking-in pipe 22 to the wall face of the cooling warehouse 14, setting the in-warehouse-air taking-in pipe 22 to the outside of the wall face of the warehouse 14, and setting the cooled-air feeding fan 24 as shown in Fig. 2. The in-warehouse-air taking-in pipe 34 and the cooled-air feeding fan 36 are set in the cooling warehouse 14. Therefore, when remodeling and forming an existing warehouse into a cooling warehouse of this embodiment, construction is easily completed.

In the case of this embodiment, an object to be

cooled by the air refrigerant type cooling apparatus 1 is a cooling warehouse to be closed by closing the door. Moreover, it is possible to apply the present invention to a semi-closing-type cooling warehouse in which frozen food is prepared when food passes through a space cooled by the air refrigerant type cooling apparatus 1 by a belt conveyer. Furthermore, the present invention can be applied to a medical product reactor for cooling medicinal products in their manufacturing process.

The another embodiment of the air refrigerant type cooling apparatus of the present invention is shown in Fig. 4. The same number is put on the component similar to Fig. 1, and those explanations are omitted.

The defrosting machine 42 is intermediately connected between the expansion turbine 12 and the cooling warehouse 14. The outlet of the defrosting machine 42 is connected to the inlet of the cooling warehouse 14 through a piping 43. The piping 44 connected to the outlet of the cooling warehouse 14 diverges to a piping 46 and a piping 48 through a three way valve. The piping 46 is connected to the inlet of the defrosting machine 42. The piping 48 is connected to the lower temperature side piping of the second cooling heat exchanger.

When this type of the air refrigerant type

cooling apparatus is driven, low temperature cooled air is exhausted from the expansion turbine 12. After moisture is removed, the cooled air is introduced to the inside in the cooling warehouse 14. The air inside in the cooling warehouse 14 is extracted by the piping 44. The air flowing in the piping 44 diverges to the piping 46 and the piping 48. The temperature of the air flowing in the piping 46 is equal to or a little higher than the temperature of the air inside in the cooling warehouse 14. The air flowing in the piping 46 is introduced to the defrosting machine 42, mixed with air exhausted from the expansion turbine 12, and flows in the cooling warehouse 14.

This embodiment also has a large quantity and speed of air similarly to the case of the embodiment described by referring to Fig. 2 and Fig. 3. For this embodiment, advantages are expected that agitation of the air in the cooling warehouse 14 is accelerated and the temperature distribution become flatter. Moreover, because the temperature of the mixed air 40 flowing in the piping 43 is closer to the temperature in the cooling warehouse 14 than the temperature of the cooled air supplied by the expansion turbine 12, there is an advantage that the temperature distribution in the cooling warehouse 14 becomes flatter. The air flowing in the piping 46 is

introduced to the cooling warehouse 14 after defrosted by the defrosting machine 42, the frost inside in the cooling warehouse 14 decreases.

Fig. 5 shows an air refrigerant type cooling system applying the air refrigerant type cooling apparatus 1 to a container. The air refrigerant type cooling system includes a vehicle 51 (freight car of railroad or ship are included) and a container 50 mounted on the vehicle 51. The container 50 loads the air refrigerant type cooling apparatus 1 and the cooling warehouse 14. The vehicle 51 loads a battery 52. The motor 4 and the fan 8 of the air refrigerant type cooling apparatus 1 and the cooled-air feeding fan 24 or 36 of the cooling warehouse 14 are fed by the battery 52 and driven. The freight in the container is cooled and transported by the air refrigerant type cooling system.